Updates in International Standards: Harmonics and Flicker

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Updates in International Standards

Introductions, Greetings, Salutations and Disclaimers
Required for CE-Mark
for distribution in EU nations
Many standards for Electromagnetic compatibility
We are concerned with the low-frequency requirements regarding interface with the mains public power supply:

- 61000-3-2 and 61000-3-12 describe limits for harmonics
- 61000-3-3 and 61000-3-11 describe limits for flicker
- 61000-4-7 describes the measuring instrument for harmonics
- 61000-4-15 describes the measuring instrument for flicker
Harmonics

Sinusoidal voltages or currents having frequencies that are whole multiples of the frequency at which the supply system is designed to operate (e.g. 50Hz or 60 Hz)

Example of Fundamental, plus 5th harmonic signal

Courtesy: Mathieu van den Bergh
Harmonics

Causes:

Nonlinear loads; with current and voltage waveforms that are nonsinusoidal or that contain distortions.

These place additional waveforms onto the fundamental waveform, creating multiple frequencies within the normal 50- or 60-Hz sine wave. The multiple frequencies are harmonics of the fundamental frequency.

Examples include:

switching mode power supplies, battery chargers, electronic ballasts and variable frequency drives.
Harmonics

The typical rectifier-capacitor ac-dc power converters used in 'linear' and switch-mode ac-dc power converters to create their unregulated dc voltage rails present a non-linear load to the mains supply. Since they only 'top up' their dc storage capacitors at the peaks of the ac supply waveform, their supply current consumption is discontinuous, non-sine wave, and rich in harmonic currents.

Non-linear currents in a rectifier-capacitor type ac-dc converter

Peak current can be more than 3 times the maximum expected sinusoidal current for a given power

Courtesy: REO
Harmonics

Comparison of waveforms and spectra

A sine-wave current

A typical non-linear current from a single-phase rectifier-capacitor power converter

Courtesy: REO
Negative consequences of Harmonics:

- Neutral conductor: Overloading due to non-linear load
- Capacitors: Lower Impedance for higher frequencies results in higher thermal loading
- Motors: Additional losses & undesired vibrations
- Switches/breakers: Must be overdimensioned which may result in problems with overload detection
- Transformers: Increased losses due to changes in eddy currents.
Negative consequences of Harmonics:

- Conductors: Skin-effect losses/heating lower transmitted power
- Protection: Fuses melt too soon – electronic breakers do not respond at designed levels
- Electronics: Multiple zero-crossings can cause problems
- General: Additional cost due to filtering & required over-dimensioning of conductors / breakers / transformers.

Courtesy: Mathieu van den Bergh
Recent and Future Standards for Harmonics

Overview of international standards relating to harmonics and flicker.

<table>
<thead>
<tr>
<th>Harmonic Limits</th>
<th>IEC</th>
<th>DOW</th>
<th>Valid until</th>
<th>OJEU</th>
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DOW = Date of withdrawal: The latest date by which national standards conflicting with an EN (and HD for CENELEC) have to be withdrawn. OJEU = Official Journal Of The European Union. CD = Committee draft. CDV = Committee draft for vote. FDIS = Final draft international standard.
Harmonics Equipment Classes

Class A
- Balanced three-phase equipment
- Household appliances except equipment identified as Class D
- Tools excluding portable tools
- Dimmers for incandescent lamps
- Audio equipment

Class B - Portable tools

Class C - Lighting equipment

Class D
- Equipment having a specified power according less than or equal to 600W, of the following types:
  - Personal computers and personal computer monitors
  - Television receivers

*Classification of devices according to EN61000-3-2/A14*
Harmonics - Methodology

• In a standardized test, the test sample is fed by a purely sinusoidal and stable voltage from a power source.

• It must be made clear that the measured current harmonics come from the test sample and are not generated from the source.

• The power analyzer then measures the presence or absence of distortion and voltage stability of the source in each analysis window of 10, 12 or 16 periods.
Changes

IEC 61000-3-2 A1 Ed.3: EMC Part 3-2:
Limits for harmonic current emissions: equipment input \( \leq 16 \) A / phase

77A/625/FDIS
Distributed on 30 NOV 2007; Voting closed 1 FEB 2008

IEC 61000-3-2 A2 Ed.3: EMC Part 3-2:
Limits for harmonic current emissions: equipment input \( \leq 16 \) A / phase

77A/674/FDIS
Distributed on 14 NOV 2008; Voting closed 16 JAN 2009

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EN61000-4-7

- Harmonic Analyzer
  - 10 period interval (about 200ms)
  - Smoothing
  - Accuracy Class I

- Actual (2009-08-26):
  - EN61000-4-7:2002
  - EN61000-4-7:2002/A1:2009
Harmonic Analyzer

- 10 period interval (about 200ms)
- Smoothing
- Accuracy Class I

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Flicker

IEC 61000-3-3 Ed.2: Electromagnetic compatibility (EMC) - Part 3-3: Limits

Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current $\leq 16$ A per phase and not subject to conditional connection

77A/644/FDIS
Distributed on 14 MAR 2008; Voting closed 16 MAY 2008

Flicker

EN61000-3-3
Flicker and voltage changes

Flicker is determined by the amplitude and frequency of line voltage fluctuations. Voltage fluctuations in turn occur in the mains network impedance through the repeated sudden current variations of a consumer on the network.
EN61000-3-3

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Flicker Background

- Changing current causes changing voltage which causes changing light

- Reference impedance
Flicker

Measurement:

In order to obtain comparable measured results, a standardized mains network impedance must be inserted between the infeed source and the test sample when measuring flicker.
EN61000-3-3

- Flicker <= 16A per phase:
  - $P_{st} < 1.0$, $P_{lt} < 0.6$
  - $d_c < 3.3\%$, $d_{max} < 4\%-7\%$ depending on device
  - $d(t) > 3.3\%$ only < 500ms

- Actual (2009-08-26):
  - EN61000-3-3:1995/A2:2005
  - EN61000-3-3:2008

- Reference impedance
  - $(0.24 + j 0.15)\Omega$ in line
  - $(0.16 + j 0.10)\Omega$ in neutral
@ 1058 fluctuations per minute (approx. 8.8 Hz) human sensitivity for flicker phenomena is greatest (Pst=1 is lowest). EN61000-3-3 also defines limits for the maximum voltage change allowable in appliances for initial and sustained operation.
Flicker: Test Procedures Specified

- Cookers
- Hotplates
- Baking Ovens
- Grills
- Microwave Ovens
- Lighting
- Washing Machines / Dryers
- Refrigerators
- Copy Machines / Laser Printers
- Vacuum Cleaners
- Mixers
- Portable Tools
- Amplifiers
- Welding Tools
- Televisions
EN61000-4-15

- Flickermeter Standards
- Actual (2009-08-26):
  - 77A/687/CDV (2009-08-07)
- Soon: IEC61000-4-15:2010
- 77A/722/FDIS
Flickermeter

CE-Conformity • SYS61K Test System
EN 61000-3-2 Harmonics
EN 61000-3-3 Flicker
Thank you for your attention.

Questions?